F1008

Attachment H

COVER SHEET (PAGE 1 of 2)

May 1998 CALFED ECOSYSTEM RESTORATION PROPOSAL SOLICITATION

Proposal Title: FOOD WEB INTERACTIONS AMONG ORGANISMS IN THE DELTA
Applicant Name: PEGGY LEHMAN, DEPT. WATER RESOURCES
Mailing Address: 3251 S STREET, SACRAMENTO, CA 95816
Telephone: (916) 227-7551
Fax: (916) 227-7554

Amount of funding requested: $ 272617 for 1.12 years

Indicate the Topic for which you are applying (check only one box). Note that this is an important decision: see page __ of the Proposal Solicitation Package for more information.

- ☐ Fish Passage Assessment
- ☐ Fish Passage Improvements
- ☐ Floodplain and Habitat Restoration
- ☐ Gravel Restoration
- ☐ Fish Harvest
- ☒ Species Life History Studies
- ☐ Watershed Planning/Implementation
- ☐ Education
- ☐ Fish Screen Evaluations - Alternatives and Biological Priorities

Indicate the geographic area of your proposal (check only one box):

- ☐ Sacramento River Mainstem
- ☐ Sacramento Tributary: _____
- ☒ Delta
- ☐ East Side Delta Tributary: _____
- ☐ Suisun Marsh and Bay
- ☐ San Joaquin Tributary: _____
- ☐ San Joaquin River Mainstem
- ☐ Other: _____
- ☐ Landscape (entire Bay-Delta watershed)
- ☐ North Bay: _____

Indicate the primary species which the proposal addresses (check no more than two boxes):

- ☐ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☒ Spring-run chinook salmon
- ☐ Late-fall run chinook salmon
- ☐ Fall-run chinook salmon
- ☐ Delta smelt
- ☐ Longfin smelt
- ☐ Splittail
- ☒ Steelhead trout
- ☐ Green sturgeon
- ☐ Striped bass
- ☐ Migratory birds

COVER SHEET (PAGE 2 of 2)

May 1998 CALFED ECOSYSTEM RESTORATION PROPOSAL SOLICITATION

Indicate the type of applicant (check only one box):

- [x] State agency
- [ ] Federal agency
- [ ] Public/Non-profit joint venture
- [ ] Non-profit
- [ ] Local government/district
- [ ] Private party
- [ ] University
- [ ] Other: _____

Indicate the type of project (check only one box):

- [ ] Planning
- [ ] Implementation
- [ ] Monitoring
- [ ] Education
- [x] Research

By signing below, the applicant declares the following:

(1) the truthfulness of all representations in their proposal;

(2) the individual signing the form is entitled to submit the application on behalf of the applicant (if applicant is an entity or organization); and

(3) the person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section II.K) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

(Signature of Applicant)

II. EXECUTIVE SUMMARY

Project Title: Food Web Interactions among Organisms in the Delta
Applicant: Peggy Lehman, Department of Water Resources, plehman@water.ca.gov

Project Description and Primary Biological/Ecological Objectives:
Project description: The purpose of this study is use carbon, nitrogen and sulfur isotope ratios to trace the path of organic matter through the Delta food web to the level of fish. This information will indicate the importance of food sources at the base of the food web to fish production and the major feeding interactions among fish and other organisms in the Delta or who eats whom? Spring-run Chinook salmon, steelhead and green sturgeon will be included in the study, either directly or by surrogates. This information can be used to assist development of accurate conceptual models of the food web that can be used to facilitate the CALFED goal of restoring ecosystem process and function to the Delta. Questions that the study will address include:

1) What is the relative importance of detritus, bacteria and phytoplankton to the zooplankton diet?
2) Is there a seasonal or spatial variation in the importance of detritus, bacteria and phytoplankton to the zooplankton diet?
3) What is the diet of larval, juvenile and adult fish?
4) How does the diet of larval, juvenile and adult fish change seasonally?
5) What are the most important food sources needed at the base of the Delta food web to support larval, juvenile and adult fish?

Objective: This project provides information on the diet of organisms in the Delta that can be used to develop strategies for conservation, restoration and management of the Delta food web. The information will assist the CALFED objectives to enhance ecosystem function and process in the Delta, including 1) restoration of phytoplankton and zooplankton biomass 2) increasing productivity of the food web, 3) restoring food web productivity for target species including Delta smelt, longfin smelt, splittail, spring-run **Chinook salmon, steelhead, green sturgeon**, striped bass and resident fish, and 4) reducing unnatural levels of predation and competition for target species.

Approach/Tasks/Schedule:
Approach: The flow of organic matter will be determined by ^{13}C, ^{15}N and ^{34}S isotope ratios of samples taken at multiple levels of the food web - detritus, bacteria, phytoplankton, zooplankton and clams and larval, juvenile and adult fish. Comparisons of these ratios will indicate organic matter flow in the food web and will be used to construct a quantitative conceptual model of the Delta food web or who eats whom.

Tasks: 1) Contract management (1 month), 2 and 3) Field sampling and sample analysis (8 months). 4) Data analyses and development of a quantitative conceptual model of organic matter flow in the food web (3 months). 5) Preparation of reports and journal publications (3 months). Schedule for completion: 15 months.

Justification for Project and Funding by CALFED
Our knowledge of Delta food web interactions is insufficient to successfully conserve and restore ecosystem processes and function or increase production in the Delta. This lack of information on the relative importance of different foods to the Delta food web and predator/prey interactions could negatively impact development of CALFED restoration projects and management programs. A major assumption of the CALFED ERPP (1997) is that increased organic matter loading to the estuary from upstream wetlands will restore estuarine production, but there is no experimental justification for this assumption. In fact, research has demonstrated the importance of phytoplankton to the food web despite large inputs of organic material from wetlands (Keough et al. 1996).

Our current conceptual model of the flow of organic matter and feeding interactions among species in the estuary are primarily based on correlation between predator and prey species, behavior of species in other ecosystems, ecological theory and gut analyses. Correlation analysis, ecological theory and information from other ecosystems can be used to develop conceptual models of the estuary, but the accuracy and applicability of available information bias these approaches. Gut content studies are a direct measure of the food consumed by organisms, but provide limited information about the true diet. \ Many of these problems can be eliminated with isotope ratio analysis which indicates food sources incorporated into body tissue of the animal during its lifetime. Multiple isotope ratios are routinely and successfully used to trace the flow of organic matter among trophic levels in aquatic food webs (Peterson et al. 1985; Peterson and Howarth 1987; Hansson et al. 1997), and were successfully used to trace organic matter flow in striped bass (Rast and Sutton 1989) and *Potamocurbula amurensis* (Canuel et al. 1995) in the Delta.

Budget Costs and Third Party Impacts: $272617. There are no third party impacts.

Applicant Qualifications:
Collaborators for this project are Ph.D. and masters level senior scientists from UC Davis and State of California, who are experts in their field and have extensive research experience.

Monitoring and data evaluation:
Isotope ratios will be determined monthly during the spring and summer for lower food web organisms and once each during the spring and summer of upper food web organisms. Data analyses will be reviewed by IEP project work teams: Estuarine Ecology Team and Resident Fish Team and the UC Davis Suisun Marsh Program .

Local Support/Coordination with other Programs/ CALFED objectives:
This study will be done in conjunction with 1) IEP monitoring programs - Real Time, Bay Delta Study and Compliance Water Quality and 2) the UC Davis Suisun Marsh Fish Monitoring Program. By determining the relative importance of organic matter to the Delta food web, this study will complement an organic matter source study previously funded by CALFED.

III. TITLE PAGE

Title of Project:
Food Web Interactions among Organisms in the Delta

Name of Applicant:
Peggy Lehman
Environmental Services Office
Department of Water Resources
3251 S Street, Sacramento, CA 95818
phone: (916)227-7551
FAX: (916) 227-7554

Type of Organization and Tax Status:
State organization

Tax Identification Number and/or Contractor license:
Not applicable

Participants and Collaborators:

Lower food web organisms:	Peggy Lehman Department of Water Resources, 3251 S Street, Sacramento CA
Fish:	Scott Matern and Peter Moyle Dept. Fish, Wildlife and Conservation Biology, UC Davis, Davis CA
Food web modeling:	Sam Bledsoe, Department of Civil Engineering UC Davis, Davis CA
Isotope analyses:	Howard Spero and Robert Zierenberg Department of Geology UC Davis, Davis CA
Zooplankton:	Jim Orsi Department of Fish and Game 4001 N. Wilson Way Stockton CA

IV. Project Description

a. Project Description and Approach

Project description: The purpose of this study is use carbon, nitrogen and sulfur isotope ratios to trace the path of organic matter through the Delta food web from bacteria to the level of larval, juvenile and adult fish. This information will provide insight into the importance of food sources at the base of the food web and the important feeding interactions among organisms in the Delta or who eats whom? The feeding interactions for spring-run Chinook salmon, steelhead and green sturgeon will be included in the study directly or by surrogates. Knowledge of the feeding interactions and important food sources at the base of the food web will assist restoration of ecosystem process and function that will benefit both target and non-target species in the Delta. It will guide IEP research, CALFED restoration projects and IEP and CALFED management strategies. Questions that the study will address include:

1) What is the relative importance of detritus, bacteria and phytoplankton to the zooplankton diet?
2) Is there a seasonal or spatial variation in the importance of detritus, bacteria and phytoplankton to the zooplankton diet?
3) What is the diet of larval, juvenile and adult fish?
4) How does the diet of larval, juvenile and adult fish change seasonally?
5) What are the most important food sources needed at the base of the estuarine food web to support larval, juvenile and adult fish?

The project includes lower and upper food web study elements. The lower food web study element will determine the monthly flow of organic matter among detritus, bacteria, phytoplankton and zooplankton during the spring and summer; April through September. The upper food web study element will be coupled with the lower food web study element once each in the spring and summer in order to determine the organic matter flow from the base of the food web to adult fish. Spatial variation of the organic matter flow in the Delta will be determined by sampling at five stations located throughout the Delta: Suisun Marsh, Suisun Bay, and the northern, central and southern Delta.

Methods detail: *Sampling*: Samples will be collected at five stations in the Delta, Suisun Bay and Suisun Marsh monthly between April and September for the lower food web study and seasonally for the upper food web study.

Replicate samples for dissolved organic matter, detritus, bacteria and phytoplankton will be collected using a pump. Water samples for bacteria and phytoplankton will be filtered onto precombusted filters. Detritus and higher plant material will be obtained from material collected in net samples or harvested directly. Zooplankton will be collected by a zooplankton net, placed in filtered water for 24 hr to evacuate the gut and separated into species. Larval, juvenile and adult fish will be obtained during ongoing monitoring studies. Larval fish will be collected, immediately frozen and identified to species in the laboratory. Tissue samples for juvenile and adult fish will be taken in the field and

frozen. All samples for analysis will be dried, ground and rinsed as appropriate and $d^{13}C$, $d^{15}N$ and $d^{34}S$ ratios will be determined by an isotope mass spectrometer.

Up to 10 fish species total will be collected at each station from the following six feeding categories: plankton/benthic, salmonids, plankton filter feeder, YOY piscivores, plankton "pickers" and obligate benthic feeders; the fish species collected will differ among stations. Fish collections will focus on the larval and juvenile life stages because these are more affected by food at the base of the food web. Species of special interest, such as chinook salmon (smolt), steelhead, green sturgeon, threadfin shad, splittail, striped bass, delta smelt and longfin smelt, will be collected when they are available; only up to 2 per station are expected.

We recognize that collecting green sturgeon, steelhead and spring-run salmon in the Delta can be difficult and in the case of green sturgeon, nearly impossible. We therefore propose to gain an understanding of their feeding interactions using surrogate species when necessary. Spring-run sized salmon should be available since they are often collected from April to September in the Chinook Salmon Monitoring Program, but any salmon of the same size should feed similarly. Steelhead should feed similarly to the rainbow trout that are commonly caught at Chipps Island in April and to other salmonids in the Delta. Green and white sturgeon should not have different feeding habits and larval, juvenile and adult white sturgeon are often collected in the Delta (personal communication R. Schaffter).

Zooplankton and invertebrate samples will focus on species that are abundant and expected food for fish, including the zooplankton, *Pseudodiaptomus forbesi, Acartiella sinensis, Limnoithona tetraspina, Eurytemora affinis, Acanthomysis bowmani, Daphnia* spp., *Neomysis mercedis, Palaemon macrodactylus, Crangon franciscorum, Gammarus* spp., *Corophium* spp. and insects, Diptera.

Isotope analysis: The flow of organic matter will be determined by ^{13}C, ^{15}N and ^{34}S isotope ratios of samples taken in multiple levels of the food web - detritus, bacteria, phytoplankton, zooplankton and clams and larval, juvenile and adult fish. Single and multiple comparisons of these ratios indicate organic matter pathways in the food web, because isotope ratios are either the same or increase by 1-4% between producers and consumers. Multiple isotope ratios are a common and successful method used to trace the flow organic matter through aquatic food webs; including estuaries (Peterson et al. 1985; Peterson and Howarth 1987; Hansson et al. 1997). This study will include identification of the ^{34}S isotope ratio which was found to be particularly helpful in discriminating between organic matter sources in estuaries (Peterson et al. 1985; Peterson and Howarth 1987).

b. Proposed Scope of Work

Tasks: 1) contract management (1 month), 2 and 3) field sampling and sample analysis (8 months). 3) data analysis and development of a quantitative conceptual model of organic

matter flow in the food web (3 months). 4) preparation of report and journal publication (3 months). Schedule for completion: about 15 months.

c. Location and/or Geographic Boundaries of the Project
Delta Basin and Suisun Marsh and San Francisco Bay (RFP Attachment A)

d. Expected Benefits
The project will provide information to develop strategies for conservation, restoration and management of food web resources that will restore ecosystem function and process in the Delta. Knowing who eats whom or what will enable efficient and effective management to enhance food availability for targeted species and reduce undesirable predator/prey interactions. We also expect that good habitat for the food web in general, will be good habitat for target species. Primary habitats: Tidal perennial aquatic habitat (freshwater), instream aquatic habitat and saline emergent wetlands (tidal). Primary species: 1st Tier: winter-run, spring-run, Sacramento late fall-run and San Joaquin fall-run Chinook salmon, steelhead and delta smelt. 2nd Tier: longfin smelt, splittail. Secondary species: striped bass, Sacramento fall-run Chinook salmon. Primary stressors: undesirable species interactions (spring-run chinook, San Joaquin fall-run Chinook, Delta smelt, steelhead, longfin smelt, striped bass) and food web production (Delta smelt, winter-run Chinook, longfin smelt, striped bass).

e. Background and Ecological/Biological/Technical Justification
Background for project: Our insufficient knowledge of estuarine food web interactions lead the Estuarine Ecology Team to list the role of different organic matter sources to the food web and the feeding interactions among species as high-priority questions for the Interagency Ecological Program (IEP 1995). These questions will increase in importance as we examine the mechanisms behind X2 relationships (Jassby et al. 1996) needed for management and restoration. In addition, feeding interactions and food availability are major components of ecosystem process and function that the CALFED ERPP lists as a primary goal and are necessary to facilitate enhancement of habitat for target species.

Our current conceptual model of the flow of organic matter and feeding interactions among species in the estuary are primarily based on correlation between predator and prey species, behavior of species in other ecosystems, ecological theory and gut analyses. Correlation analysis (Orsi and Mecum 1996), ecological theory and information from other ecosystems can be used to develop conceptual models of the estuary (IEP 1995), but the accuracy and applicability of available information bias these models. Gut content studies directly measure food consumed by organisms and have been used to determine the food sources of fish in the Delta, including striped bass (Stevens 1966), Delta smelt (Nobriga 1998), Chinook salmon, steelhead and Sacramento sqawfish (Kjelson et al. 1982; Merz and Vanicek 1996). Gut contents have also provided information on the feeding of planktonic invertebrates, including the mysid shrimp, *Neomysis mercedis* (Kost and Knight 1975), copepods and cladocerans (Orsi 1995).

Gut content analysis, however, provides limited information about the true diet. Gut content studies only identify food that can be visually identified and the importance of digested or partially digested food, and difficult to see or amorphous food items, such as detritus or bacteria, cannot be determined. Gut content studies also do not indicate the true importance of the food to the diet because of differential digestion and the gut content on the day the animal was sampled may not be representative of its lifetime feeding history. Lastly, gut contents provide little information on the trophic interactions that produced the observed food.

Many of the problems associated with the use of gut contents to characterize the flow of organic matter sources and species food web interactions are reduced with isotope ratio analysis, because the isotope signal indicates food sources that have been incorporated into body tissue throughout the life of an organism. Multiple isotope ratios are routinely and successfully used to trace the flow of organic matter among trophic levels in aquatic food webs (Peterson et al. 1985; Peterson and Howarth 1987; Hansson et al. 1997). In the Delta, d13C and d15N isotope ratios were successfully used to trace the general pattern of organic matter flow in striped bass (Rast and Sutton 1989) and *Potamocurbula amurensis* (Canuel et al. 1995) food webs.

Citations

Canuel, E. A., J. E. Cloern, D. B. Ringelberg, J. B. Guckert and G. K. Rau. 995. Using molecular and isotopic tracers to examine sources of organic matter and its incorporation into the food webs of San Francisco Bay. Limnol. Oceanogr. 40:67-81.

Keough, J. R., M. E. Sierszen and Ca. A. Hagley. 1996. Analysis of a Lake Superior coastal food web with stable isotope techniques. Limnol. Oceanogr. 41:136-146.

Hansson, S., J. E. Hobbie, R. Elmgren, U. Larsson, B. Fry and S. Johansson. 1997. The stable nitrogen isotope ratio as a marker of food-web interactions and fish migration. Ecology 78:2249-2257.

Interagency Ecological Program. 1995. "Working conceptual model for the food web of the San Francisco Bay/Delta Estuary. Interagency Ecological Program for the San Francisco/Bay Delta. Technical Report 42.

M. A. Kjelson, P. F. Raquel and F. W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin Estuary California, pp. 393-411. In V. S. Kennedy (ed.), *Estuarine Comparisons*. Academic Press, New York.

Kost, A. L. B. and A. W. Knight. 1975. The food of Neomysis mercedis Holmes in the Sacramento-San Joaquin Delta ecosystem. Calif. Fish Game 61: 34-41.

Merz, J. E. and C. D. Vanicek. 1996. Comparative feeding habits of juvenile Chinook salmon, steelhead and Sacramento squawfish in the lower American River, California. CA Fish and Game 82:149-159.

Nobriga, M. L. 1998. Trends in the food habits of larval Delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, CA, 1992-1994. Masters Thesis. CA State University, Sacramento.

Orsi, J. J. 1995. Food habits of several abundant zooplankton species in the Sacramento-San Joaquin Estuary. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Sacramento CA. Tech. Rpt. 41.

Orsi, J. J. and W. Mecum. 1996. Food limitation as the probable cause of a long-term decline in the abundance of *Neomysis mercedis* the Opossum Shrimp in the Sacramento-San Joaquin estuary, p. 375-402.351-374. In J. T. Hollibaugh (ed.), San Francisco Bay: The Ecosystem. Pac. Div. Amer. Assoc. Adv. Sci., San Francisco CA 94118.

Peterson, F. J. and R. W. Howarth. 1987. Sulfur, carbon, and nitrogen used to trace organic matter flow in the salt-marsh estuaries of Sapelo Island, Georgia. Limnol. Oceanogr. 32:1195-1213.

Peterson, B. J., R. W. Howarth and R. H. Garritt. 1985. Multiple stable isotopes used to trace the flow of organic matter in estuarine food webs. Science: 227:1361-1363.

Rast, W. and J. E. Sutton. 1987. Use of stable carbon and nitrogen isotopes to trace the larval striped bass food chain in the Sacramento-San Joaquin Estuary, California, April to September 1985. U. S. G. S. Water-Resources Investigations Report 88-4164.

Stevens, D. 1966. Food habits of striped bass, *Roccus saxatilis*, in the Sacramento-San Joaquin Delta. CA. Fish and Game Bull. 136:68-96.

Need for project: The lack of information on the relative importance of different foods to the Delta food web could negatively impact restoration projects and management programs that strive to restore ecosystem process and function or increase habitat for target species. For example, a major assumption of the CALFED (1997) Estuarine Restoration Program Plan is that an increase in total and dissolved organic matter loading to the estuary from upstream wetlands will restore estuarine production, but there is no experimental justification for this assumption. In fact, research has demonstrated the importance of phytoplankton to the food web despite a large input of organic material from wetlands (Keough et al. 1996). In addition, current management of fishery resources is dependent on flow regulation (X2), but the wisdom and long-term effects of this approach are unknown, because it is unknown how flow affects feeding relationships.

Estuarine Restoration Program Plan objectives and targets:
Below are sections in the ERPP that discuss the need for this type of information:

Ecosystem Restoration Program Plan
Objectives

Objective	Section	Volume	Page
Restore phytoplankton biomass in the Delta	Ecological Process Visions	I	63
Restore zooplankton biomass in the Delta	Ecological Process Visions	I	63
Restore food web	Habitat Visions	I	
	Riparian and Riverine	I	111
	Saline Emergent Wetland	I	96
	Fresh Emergent Wetland	I	100
Restore food web productivity	Species and Species Group Visions	I	
	Delta smelt	I	134,136
	Longfin smelt	I	138,139
	Splittail	I	143,144
	Chinook salmon	I	152
	Steelhead	I	158,160
	Striped bass	I	163-165
	Resident Fish	I	170,171
	Delta food web	I	179,181

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	Visions for elimination of stressors		
Reduce unnatural levels of predation and competition	Sacramento-San Joaquin Delta Ecological Zone	I	317-322
		II	33
Increase food web production	Sacramento-San Joaquin Delta Ecological Zone	II	24,24,45
	Suisun Marsh / N. San Francisco Bay Ecological Zone	II	83,86,87

This project also address the objectives of the Anadromous Fish Restoration Plan to enhance and restore habitat for salmon and steelhead, by determining their habitat needs and impacts from predators.

f. Monitoring and Data Evaluation:
Data will be collected in conjunction with the IEP Compliance, the Real Time, Chinook Salmon and Bay Delta Study Monitoring Programs and the UC Davis Suisun Marsh Fish Monitoring Program.

Spatial and temporal variation of feeding among aquatic organisms will be determined from multiple isotope ratios and will be used to construct a quantitative conceptual model of the food web that indicates the percent contribution of food sources to each food web species. The relative importance of sources of spatial and temporal variation will be determined by analysis of variance.

The project will include a quality assurance component that evaluates method and sample variability.

The data will be evaluated with the advice and review of the IEP Estuarine Ecology Team and the Resident Fish Team. Information from the study will also be evaluated in conjunction with fish diet results from graduate student research projects done in conjunction with the UC Davis Suisun Fish Monitoring Program.

g. Implementability
The project is fully implementable. The project will be done in conjunction with existing IEP, USFWS and UCD monitoring programs. Issues relating to take of endangered species are not expected to be a problem, because the project will have no additional take of threatened or endangered species.

V. Costs and Schedule

a. Budget

		Direct labor hours	Direct salary and benefits	Overhead labor	Service contracts	Material/ acquisition contracts	Misc costs	Total cost
Task 1	**Contract management**							
	Lehman	176	5000	5000				10000
	Subtotal	176	5000	5000	0	0	0	**10000**
Task 2	**Sampling**							
	Lehman	352	10000	20000			1500	31500
	Matern	352	8652	3461			1900	14013
	Sci aid	528	3000	9000				12000
	Sci aid	528	3000	9000				12000
	Subtotal	1760	24652	41461	0		3400	**69513**
Task 3	**Sample processing**							
	Lehman	176	5000	5000				10000
	Matern	176	4326	1730				6056
	Sci aid	528	3000	3000				6000
	Sci aid	528	3000	3000				6000
	lab assist	201	1194	1361				2554
	taxonomist	176	2000	2000				4000
	Spero	21	950	380	30334			31665
	Zierenberg	21	950	380	30334			31665
	Subtotal	1827	20420	16851	60668	0	0	**97940**
Task 4	**Data analysis**							
	Lehman	352	10000	10000				20000
	Matern	352	8652	3461				12113
	Sci aid	176	1000	1000				2000
	Sci aid	176	1000	1000				2000
	Bledsoe	176	7425	2970				10395
	Spero	44	1980	792				2772
	Zierenberg	44	1980	792				2772
	Moyle							0
	Orsi							0
	Subtotal	1320	32037	20015	0	0	0	**52052**
Task 5	**Reporting**							
	Lehman	352	10000	10000				20000
	Matern	176	4326	1730				6056
	Sci aid	176	1000	1000				2000
	Sci aid	176	1000	1000				2000
	Bledsoe	176	7425	2970				10395
	Spero	21	950	380				1331

	Zierenberg	21	950	380			1331
	Moyle						0
	Orsi						0
	Subtotal	1098	25652	17461	0	0	0 43113
Grand total							**272617**

Cost sharing: There will be significant cost sharing because the sampling phase of the project will be done as a part of existing monitoring studies including the Bay-Delta Monitoring Study, Real Time Monitoring, Chinook Salmon Monitoring Program, Compliance Monitoring and the UC Davis Suisun Marsh Fish Monitoring Program. Daily boat costs of about $300 plus the cost of an operator and 2 crew could run as high as $60000 for this study. In addition, data from this isotope study will be compared with data from on-going research on fish diet in the Marsh that are separately funded masters and Ph.D. projects at UC Davis.

b. Schedule Milestones
Task 1: 1-3/99; Task 2: 4-9/99; Task 3: 4-10/99; Task 4: 10-12/99; Task 5: 1-3/2000. Quarterly updates will be presented to IEP Work Teams.

c. Third Party Impacts: No third party impacts.

VI. Applicant Qualifications

P. Lehman is a Ph.D. in ecology with an emphasis in aquatic ecology and is a senior scientist at DWR. She has published reports and journal articles on phytoplankton ecology, water quality and higher plant physiology in the Delta.

S. Matern is a doctoral candidate in ecology, working with Peter Moyle at UC Davis. He is responsible for the Suisun Marsh Fish Sampling program and is an expert in Delta fish sampling techniques and taxonomy.

S. Bledsoe is a professor of civil engineering at UC Davis and an expert in theoretical modeling of food webs.

H. Spero and R. Zierenberg are professors in Geology at UC Davis and are experts in the measurement and use of isotopes. Samples will be processed at their labs.

Peter Moyle is a professor in Fish, Wildlife and Conservation Biology at UC Davis and is an internationally known fish expert.

Jim Orsi has an M.S. in Marine Fisheries and is a senior scientist at DFG. He has 26 years experience as a project leader for zooplankton studies in the Delta and has authored 14 articles on Delta zooplankton.

ITE

Agreement No. _____

Exhibit ____

STANDARD CLAUSES -
INTERAGENCY AGREEMENTS

Audit Clause. For contracts in excess of $10,000, the contracting parties shall be subject to the examination and audit the State Auditor for a period of three years after final payment under the contract. (Government Code Section 8546.7).

Availability of Funds. Work to be performed under this contract is subject to availability of Category III funds through th State's normal budget process.

Interagency Payment Clause. For services provided under this agreement, charges will be computed in accordance w State Administrative Manual Section 8752.

Termination Clause. Either State agency may terminate this contract upon 30 days advance written notice. The State agency providing the services shall be reimbursed for all reasonable expenses incurred up to the date of termination.